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Nursery Diseases of Western Conifers

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Forest tree nurseries in the Western United States, the region immediately west of the Great Plains, currently produce over 250 million trees per year. Recent Federal legislation requires the Forest Service to increase its efforts in reforestation of nonstocked forest land, and some States now require owners of forest land to provide for reforestation immediately after an area is cut over. These actions will increase the need for more seedlings and create a demand for greater production from forest nurseries. To attain this goal, uniform, vigorous, high-quality seedlings must be produced and disease losses kept to a minimum.

It is beyond the scope of this leaflet to cover all known nursery diseases of western conifers. The objectives are to describe briefly some of the more important seedling diseases, and to suggest general types of control procedures. Diseases are grouped according to the plant part affected: foliage, stems, or roots. More detailed information is available in Agriculture Handbook 470, "Forest Nursery Diseases in the United States" (Peterson and Smith 1975). If professional assistance is required, the nurseryman should contact a plant pathologist through agencies such as: State

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Foliage Diseases

Fungi that cause foliage diseases usually require conditions of high moisture and free water in and around stems and foliage for long periods of time to establish infection. Such moisture occurs during extended periods of rain or fog, or during continued use of overhead irrigation. Foliage diseases are most prevalent and most important in locations having frequent summer rains, and along the north Pacific Coast where summer fogs increase humidity and free moisture for extended periods.

Rosellinia needle blight defoliates Douglas-fir and Sitka spruce seedlings in the center of overstocked beds in nurseries along the north Pacific Coast. The causal fungus, *Rosellinia herpotrichoides,* appears as a fine white to gray web-like growth that covers lower needles and branches of infected seedlings. These needles become chlorotic and die. Groups of fruiting bodies originate from the web-like growth and are found on the dead lower needles and stem of infected seedlings (see photo). Although the fungus kills few seedlings, infected needles are cast, and this defoliation results in many seedlings being culled.

Dothistroma pini causes "red band needle blight" of pines along the eastern Rockies and north Pacific Coast. The disease is distinguished by a small reddish band encircling the infected needle. Fruiting bodies of the causal fungus develop during July below the needle epidermis, and raise and split the epidermis. Needles may die soon after first appearance of symptoms, and these needles are cast prematurely. The fungus often causes severe damage in pine plantations, and infection in certain new plantings has indicated that seedlings infected in the nursery have been responsible for disease outbreaks in those plantings. The fungus has been commonly found on 4- to 5-year-old pine transplants in some nurseries that produce pines for landscape plantings.

Stem Diseases

Canker, gall, and dieback pathogens attack stems and branches of nursery seedlings. They cause sunken lesions and malformations, and often kill seedlings. *Sirococcus strobilinus* causes tip blight and produces sunken, purplish cankers on the stems of current year's growth of hard pines in nurseries and in

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Figure 1.—Stem canker and black fruiting bodies of *Sirococcus strobilinus* in a cankered terminal of a 2-year-old Jeffrey pine.

natural reproduction in the Pacific Northwest. Young needles are infected first, and small black fruiting bodies develop on stem cankers and infected needles as the cankers mature (fig. 1). These fruiting bodies produce spores that are dispersed to other seedlings by splashing water droplets. The spores then germinate and infect young needles of susceptible seedlings. Restricted stem growth in a cankered area causes the terminal to curl over. Trees with multiple infections are killed; additional nursery losses result from culling of deformed stock.

Diaporthe lokoyae (imperfect stage—*Phomopsis lokoyae*) and *Cytospora* spp. cause stem cankers on Douglas-fir seedlings in nurseries in the Pacific Northwest. These diseases appear to intensify after seedlings have been subjected to drought, and are first seen as flagged branches or tops with sunken cankers at

the proximal margin of dead stems. Small black fruiting bodies develop in the cankered area, and spores produced in these fruiting bodies spread to other seedlings in water droplets. These fungi kill seedlings, but the major nursery loss is through culling of deformed stock.

Botrytis cinerea, the cause of gray mold on many tree species, is a serious problem on a few highly susceptible western conifers such as redwood and giant sequoia. The fungus commonly exists as a saprophyte on dead or dying plant parts, and readily infects healthy tissues when seedlings are grown in containers in greenhouses or in overstocked nursery beds where humidities are high and temperatures are cool for prolonged periods. A sunken canker develops after succulent seedling tissues become infected and the portion of the seedling above the canker is killed. Epidemics in California nurseries have resulted in total losses of giant sequoia in seedling beds.

Western gall rust, caused by *Peridermium harknessii*, occurs on a large number of native pine species. This disease has been a problem in forest nurseries with infected pine trees in adjacent forest stands or ornamental plantings. Round galls, formed on branches and stems of infected trees, become covered with orange aeciospores in the spring. These spores are dispersed by the wind and under suitable environmental conditions penetrate needles of young shoots of susceptible pine seedlings. The galls require 1 to 3 years to develop on seedlings infected in the nursery, and thus are often seen only on outplanted seedlings. Seedlings frequently become deformed and weakened at the site of infection as the galls enlarge. Because the fungus spreads from pine to pine, new plantations should be inspected frequently and all gall-bearing seedlings should be destroyed to prevent further spread in the field.

Root Diseases

From germination through the first few weeks after emergence, succulent radicle and hypocotyl tissues of seedlings are extremely susceptible to attack by certain damping-off fungi. *Pythium, Rhizoctonia*, *Phytophthora*, and *Fusarium* are fungi that commonly cause damping-off. Preemergence damping-off is caused by fungi that rot seedlings before they emerge. Postemergence damping-off, caused by fungi that infect and kill stem tissues at the ground line after seedling emergence, results in seedling collapse (fig. 2). Because damping-off is greatly influenced by the environment, severity of this disease fluctu-

ates from year to year. In general, conditions that reduce seedling growth and vigor predispose nursery stock to increased infection from damping-off fungi. Nitrogen fertilizers applied before or during the first few weeks after seedling emergence may also increase infection.

Charcoal root disease, caused by *Macrophomina phaseoli*, is one of the most important diseases in forest nurseries in the Western United States. Most conifer species, especially Douglas-fir, red and white fir, and giant sequoia, grown in warm lowland agricultural soils are susceptible to this disease. The causal fungus exists in the soil as small black dormant structures called sclerotia. As seedling roots grow and come in contact with these sclerotia they germinate, the fungus penetrates the root, gradually killing the root system, and the seedling becomes stunted and dies. New sclerotia formed between the bark and wood of dead roots provide a diagnostic sign to distinguish this disease from other root diseases of western conifers. In addition to seedling losses in the nursery from mortality and culling of stunted stock, infected seedlings outplanted in warm soils also may be killed by this fungus.

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Figure 2.—Postemergence damping-off of a sugar pine seedling.

Table 1.—*Common seedling diseases of western conifers and methods for their control*

Disease and Cause	Hosts
Foliage Diseases	
Rosellinia needle blight *Rosellinia herpotrichoides*	Douglas-fir, Sitka spruce
Red band needle blight *(Scirrhia pini) Dothistroma pini*	Pines—especially Monterey, Bishop, ponderosa, sugar
Stem Diseases	
Sirococcus tip blight *Sirococcus strobilinus*	Pines
Phomopsis canker *Phomopsis lokoyae*	Douglas-fir
Cytospora canker, *Cytospora* spp.	Douglas-fir True fir
Botrytis dieback, *Botrytis cinerea*	Giant sequoia, redwood, and other container-grown conifers
Western gall rust, *Peridermium harknessii*	Hard pines
Root Diseases	
Damping-off Soil-borne fungi	All hosts
Charcoal root disease, *Macrophomina phaseoli*	Pines, firs, Douglas-fir
Phytophthora root disease *Phytopthora* spp.	Conifers and hardwoods
Water mold root disease *Pythium* spp.	Containerized seedlings
Nematode-Caused Diseases	
Root lesion and root-knot *Pratylenchus and Meloidogyne* spp.	Junipers, pines
Corky root disease *Xiphinema bakeri*	Douglas-fir

Cultural Control	Chemical Control
Reduce seedbed density to improve aeration and lower humidity	None registered
Do not grow susceptible species in high-hazard areas	Bordeaux mixture effectively prevents infection
Rogue out infected seedlings; remove Sitka spruce from around nursery	Chlorothalonil, 75%; 2 lb/100 gal (2.4g/liter)
Rogue out infected seedlings; prevent moisture stress	None registered
Rogue out infected seedlings; prevent moisture stress	None registered
Decrease seedbed density; remove lath covering to promote air circulation	None registered
Remove source of rust inoculum from around nursery	
Maintain low soil pH, avoid excess soil moisture, stratify seeds	Chemical seed coating, soil fumigation
Lath shading	Preplant soil fumigation
Use growing medium with good drainage	None registered
Crop rotation	Preplant soil fumigation, postplant systemics, chemical or hot water bare-root dips
Summer fallow	Preplant soil fumigation, postplant systemics

The exact cause of many root diseases is often difficult to determine without laboratory analysis. If a root disease is suspected as a cause of the problem in a forest nursery, a pest control expert or plant pathologist should be consulted.

Nematode Caused Diseases

Nematode injury to nursery seedlings depends on type of nematodes, severity of infestation, and species and age of seedlings. In newly infested seedbeds, seedlings damaged by nematodes usually are first evident in irregularly shaped spots. These spots enlarge and coalesce over a number of years as nematodes multiply and spread throughout the seedbed.

Above-ground symptoms on seedlings parasitized by nematodes resemble those of plants lacking water and nutrients. Diseased seedlings are characterized by low vigor, stunting, and discolored foliage. Below-ground symptoms on feeder roots include root swelling, root proliferation, discoloration, lesions, necrosis, and stubby-root condition resulting from root-tip injury. Pathogenic fungi frequently enter roots through wounds made by nematodes, and the resulting disease complexes often cause considerably more loss to a seedling crop than would be caused by either acting alone.

Special techniques are required to determine if nematodes are involved in a disease problem. Diseases caused by nematodes usually cannot be diagnosed using symptoms alone since other soil-borne pathogens and some environmental factors can cause similar symptoms to develop.

Certain parasitic nematodes have a wide host range and feed on many tree species, while others are very restrictive in their feeding habits. At least 25 plant-parasitic nematode species are known to cause injury to 19 western conifer species. Some of these species, including root-lesion and root-knot nematodes, enter and complete a part of their life cycle inside feeder root tissues. Called endoparasites, they cause damage by penetrating tissues and feeding on host cells. Ectoparasitic species, including dagger nematodes, inhabit the soil immediately adjacent to feeder roots of seedlings and cause damage to roots by feeding externally on succulent root tissues. One of these species, *Xiphinema bakeri*, causes corky root disease of Douglas-fir seedlings. This disease has been observed in coastal nurseries of Western United States and British Columbia, and severe losses of Douglas-fir seedlings have occurred in several of these nurseries.

The protection afforded short

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Figure 3.—Douglas-fir ectomycorrhizae infected with *Nacobbodera chitwoodi*. Adult females (white) have ruptured the fungal mantle and are protruding from the mantle surface.

roots by mycorrhizae against pathogenic fungi may be destroyed by certain nematodes. The conversion of short roots to ectomycorrhizae during the growing season appears to have little effect on nematode infection, since several endoparasitic nematode species readily infect ectomycorrhizae of western conifers. For example, the feeding and subsequent development of *Nacobbodera chitwoodi* females disorganize internal tissues and rupture the outer fungal mantle of Douglas-fir ectomycorrhizae (fig. 3).

Control

There are two basic approaches to disease control available to nurseries: 1) cultural control, which involves changes in the growing conditions and cultural practices, and 2) chemical control, which involves selective chemicals that kill or inactivate the pathogen but do little or no harm to host seedlings.

Several cultural practices may be used to reduce or control certain nursery diseases. The development of *Rosellinia herpotrichoides* on Douglas-fir can be

inhibited by reducing seedbed density in order to lower humidity and increase air circulation around seedling foliage. Removal of hard pines infected with gall rust within a half mile of a nursery will reduce rust infection of nursery seedlings. Summer fallow, the practice of keeping land free of all vegetation, accompanied by frequent tilling, will reduce populations of *Xiphinema bakeri* by starvation and desiccation in areas of low rainfall and high soil temperatures, or in areas where rainfall is seasonal. Crop rotation with nonhost cover crops also may be used to reduce populations of certain plant-parasitic nematodes.

Chemical control may be used to protect the seedling or eradicate the pathogen. Spraying with a fungicide, for instance, protects seedlings by coating the foliage with a chemical barrier that is toxic to foliar pathogens. Such chemical control requires proper timing to coincide with periods of infection. Soil fumigation prior to planting will effectively control root disease pathogens, but seldom will it completely eradicate them.

Methods selected for controlling seedling diseases in nurseries depend on the type of disease, the environmental situation, and the relative cost of available control measures. It is difficult to draw general conclusions about which control methods to use in a particular locality, but information in table 1, which lists the most common seedling diseases found in western forest nurseries and current methods of controlling them, should provide a clue to the best control for your locality. Local Forest Service representatives or local county extension agents should be consulted to verify current and suitable chemical controls.

Caution

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key—out of the reach of children and animals—and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolinged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the Environmental Protection Agency, consult your local forest pathologist, county agricultural agent, or State Extension specialist to be sure the intended use is still registered.

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